Ohio Agricultural Experiment Station

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WOOSTER, OHIO, JUNE 23, 1911

PLANS AND SUMMARY TABLES

OF THE EXPERIMENTS AT THE CENTRAL FARM, WOOSTER,

ON THE

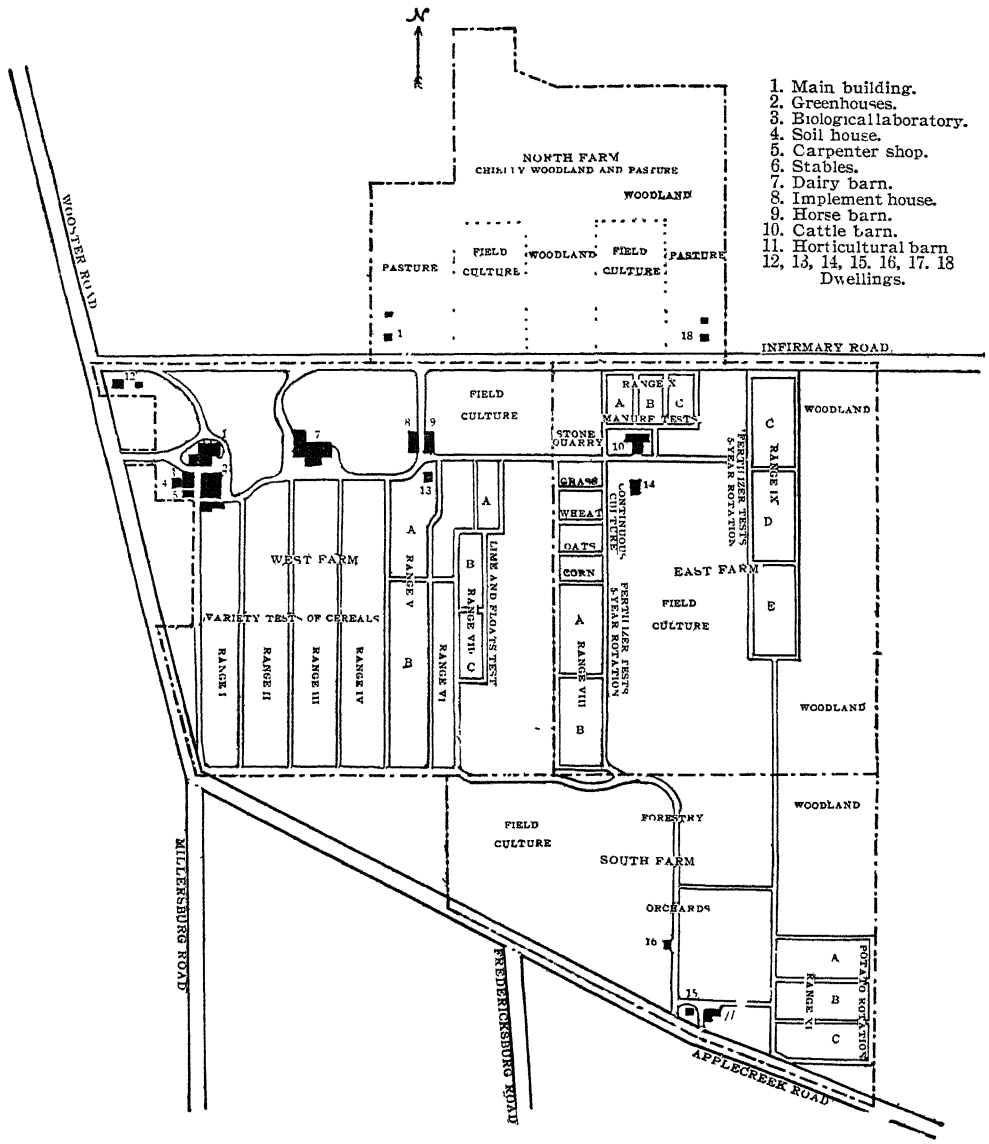
MAINTENANCE OF SOIL FERTILITY

ARRANGED FOR REFERENCE IN THE FIELD.

ANNOUNCEMENT

The experiments reported in the following pages were begun in 1893, immediately after the removal of the Experiment Station to Wayne county. The general plan of this work and the results obtained up to that time are published in Bulletin 110, issued in December, 1899, (now out of print) and again in Bulletins 182, 183, and 184, reporting to the end of 1906. It now seems desirable to follow these general publications with an annual statement, giving as briefly as possible the new data obtained from each successive crop, and referring the reader to Bulletins 182 and 183 for more complete information respecting the nature of the soils under experiment and the general plan of the work.

The results for 1907 are given in Circular No. 83, those for 1908 in Circular No. 92, and those for 1909 in Circular No. 104.



The central farm, near Wooster

FERTILIZERS AND MANURE ON CROPS GROWN CONTINUOUSLY ON THE SAME LAND

Wheat, oats and corn, one acre (10 plots) each, have been grown in this experiment since 1894. The fertilizers are applied to Plots 2 and 8 in arbitrary quantities, while on Plots 3 and 9 the three fertilizing elements, nitrogen, phosphorus and potassium, are given in approximately the same ratio to each other in which they are found in the plant.

The applications to Plots 2 and 8 have in every case produced larger average yields than those to Plots 3 and 9, but this may in part be accounted for by the combined nitrogen which is carried to the soil in rain, thus enabling the crops grown on 2 and 8 to utilize larger quantities of the phosphorus and potassium given in the fertilizer than that required merely to balance the fertilizer nitrogen.

The manure applications on Plots 5 and 6 were intended to carry nitrogen in quantities equivalent to the applications on Plots 2 and 3 on the one hand and 8 and 9 on the other, estimating the manure to carry 10 pounds of nitrogen per ton, but actual analyses of manure made during recent years indicate that this estimate was too high for open yard manure, such as is used in these tests. The average application of phosphorus and potassium in the manure closely approximates the average given to the four fertilized plots.

In this test the corn and wheat show a rapid falling off in yield on the unfertilized land during recent years. The oats also show a reduction in yield, but not so great as that of the other crops.

It is much more difficult to control the weed growth in the wheat and oats grown continuously than where the same crops are grown in rotation, and it was necessary a few years ago to divide these tracts and fallow the two ends in alternate seasons in order to destroy the weeds. Latterly the entire plots have been cropped again.

Diagram I shows the arrangement of plots and plan of fertilizing in this experiment, and the general outcome is shown in Tables I and II, which give the yields by periods.

DIAGRAM I: PLAN OF FERTILIZING IN CONTINUOUS CULTURE

PLOTS ONE-TENTH ACRE

		Fertilizing materials in pounds per acre
Wheat	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 120; dried blood, 50*
	3	Acid phos., 60; muriate potash, 30; nitrate soda, 120; dried blood, 50*
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate of soda, 280; dried blood, 50**
	9	Acid phos., 120; muriate potash, 60; nitrate of soda, 280; dried blood, 50**
	10	None
Oats	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 160
	3	Acid phos., 55; muriate potash, 50; nitrate soda, 160
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate soda, 320
	9	Acid phos., 110; muriate potash, 100; nitrate soda, 320
	10	None
Corn	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 160
	3	Acid phos., 60; muriate potash, 30; nitrate soda, 160
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate soda, 320
	9	Acid phos., 120; muriate potash, 60; nitrate soda, 320
	10	None

(South)

*120 pounds nitrate of soda plus 50 pounds dried blood is equivalent to 160 pounds nitrate of soda.
**280 pounds nitrate of soda plus 50 pounds dried blood is equivalent to 320 pounds nitrate of soda.

TABLE I: CROPS GROWN IN CONTINUOUS CULTURE. Yield and increase for 1910 and average annual yield for 17 years 1894-1910

Plot No.	Fertilizing materials — Pounds per acre	1910 Yield Grain Bus.	1910 Yield Stover or straw Lbs.	1910 Increase Grain Bus.	1910 Increase Stover or straw Lbs.	17 years, 1894 to 1910 Yield Grain Bus.	17 years, 1894 to 1910 Yield Stover or straw Lbs.	17 years, 1894 to 1910 Increase Grain Bus.	17 years, 1894 to 1910 Increase Stover or straw Lbs.	Plot No.
	Corn									
1	None	9.32	1,240	.....	.....	21.46	1,429	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda 160	25.54	2,100	18.26	937	41.70	2,312	21.85	948	2
3	" " 60; " " 30; " " 160	15.96	1,680	10.71	593	33.83	1,930	15.60	631	3
4	None	3.21	1,010	.....	.....	16.62	1,234	.....	.....	4
5	Yard manure, 2½ tons	12.68	1,530	9.15	523	27.97	1,748	11.76	529	5
6	" " 5 "	25.11	1,930	21.25	927	37.66	2,112	21.86	909	6
7	None	4.18	1,000	.....	.....	15.37	1,188	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	29.04	2,440	25.60	1,533	46.42	2,380	32.05	1,244	8
9	" " 120; " " 60; " " 320	25.86	2,280	23.16	1,467	44.01	2,248	30.63	1,164	9
10	None[a]	1.96	720	....	.....	12.38	1,032	.....	.....	10
	Average unfertilized yield	4.67	992	.....	....	16.87	1,237	.....	.....	
	Oats									
1	None	21.24	980	.....	.....	21.06	794	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	38.04	2,482	15.76	1,412	42.08	1,913	20.35	1,085	2
3	" " 55; " " 50; " " 160	34.37	1,920	11.04	760	38.30	1,658	15.89	798	3
4	None	24.37	1,250	.....	.....	23.08	893	.....	.....	4
5	Yard manure, 2½ tons	30.55	1,652	6.59	435	31.13	1,245	7.85	321	5
6	" " 5 "	42.42	2,582	18.88	1,399	38.67	1,757	15.20	802	6
7	None	23.13	1,150	.....	.....	23.67	986	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	43.74	2,950	20.59	1,818	48.11	2,449	24.05	1,461	8
9	" " 110; " " 100; " " 320	44.84	3,185	21.66	2,070	46.46	2,328	22.06	1,339	9
10	None	23.20	1,097	.....	.....	24.78	991	.....	.....	10
	Average unfertilized yield	23.73	1,119	.....	.....	23.45	921	.....	.....	
	Wheat									
1	None	6.91	1,565	.....	.....	8.16	1,132	.....	.....	1
2	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 5	22.17	3,490	15.42	2,042	20.29	2,585	12.00	1,493	2
3	" " 45; " " 30; " " 120; " " 50	19.00	2,760	12.42	1,429	16.19	1,949	7.76	895	3
4	None	6.42	1,214	.....	.....	8.56	1,013	.....	.....	4
5	Yard manure, 2½ tons	19.58	2,865	12.91	1,646	14.17	1,773	5.63	751	4
6	" " 5 "	25.33	3,840	18.41	2,615	18.36	2,302	9.83	1,274	6
7	None	7.17	1,230	.....	.....	8.51	1,039	.....	.....	7
8	Acid phos., 160; mur. potash, 100; nit. soda, 200; dried blood, 50	28.17	4,010	21.33	2,853	23.18	2,986	14.97	1,992	8
9	" " 90; " " 60; " " 200; " " 50	26.17	3,490	19.67	2,407	21.13	2,549	13.23	1,600	9
1	None	6.17	1,010	.....	.....	7.61	904	.....	.....	10
	Average unfertilized yield	6.67	1,005	.....	.....	8.21	1,007	.....	.....	

TABLE II: CROPS GROWN IN CONTINUOUS CULTURE. Average annual yield and increase per acre by 5-year periods

Plot No.	Grain						Stover or straw						Plot No.
	1894-1898		1899-1903		1904-1908		1894-1898		1899-1903		1904-1908		
	Yield Bus.	Increase Bus.	Yield Bus.	Increase Bus.	Yield Bus.	Increase Bus.	Yield Lbs.	Increase Lbs.	Yield Lbs.	Increase Lbs.	Yield Lbs.	Increase Lbs.	
Corn													
1	29.19	.....	21.85	.....	17.09	.....	1,449	.....	1,234	....	1,546	....	1
2	44.61	15.53	47.21	27.03	38.50	24.08	2,076	630	2,202	1,013	2,520	1,394	2
3	38.86	9.88	39.09	20.59	28.00	16.25	1,770	330	1,820	671	2,138	848	3
4	28.86	.....	16.81	.....	9.09	.....	1,436	.....	1,106	.....	1,162	....	4
5	36.44	8.68	29.21	12.75	23.77	14.75	1,670	278	1,588	497	1,958	773	5
6	43.13	16.49	40 11	24.01	34 62	25.65	1,938	590	1,924	851	2,404	1,195	6
7	25.53	.....	15.74	.....	8.86	.....	1,304	.....	1,060	.....	1,232	.....	7
8	44.43	20.26	52.55	37.85	44.55	36.41	2,008	749	2,376	1,358	2,568	1,415	8
9	42.76	19.96	50.13	36.45	41.73	34.34	1,870	655	2,232	1,256	2,458	1,383	9
10	21.44	.....	12.65	.....	6.64	.....	1,170	.....	934	.....	996	.....	10
	26.26	.....	16.76	.....	10.43	.....	1,339	.....	1,083	.....	1 231	.....	
Oats													
1	26.87	.....	16.75	.....	20.40	.....	892	.....	578	.....	855	.....	1
2	42.22	14.75	40.11	22.39	45.46	24.59	1,697	749	1,701	1,083	2,136	1,279	2
3	38.75	10.67	36.47	17.78	40.79	19.46	1,470	467	1 463	806	1,890	1,037	3
4	28.67	.....	19.66	.....	21.80	.....	1,059	....	697	.....	855	....	4
5	30.83	2.40	28.51	8.13	35.03	12.98	1,021	—55	1,030	283	1,565	670	5
6	34.81	6.63	36.76	15.67	44.10	21.83	1,265	173	1,516	720	2,232	1,297	6
7	27.94	.....	21.82	.....	22.55	.....	1,110	.....	846	.....	974	.....	7
8	48.75	20.37	48.87	26.51	47.89	25.17	2,086	971	2,342	1,493	2,675	1,712	8
9	46.94	18 10	47.36	24.46	45.61	22.80	1,982	862	2 131	1,078	2,548	1,601	9
10	29 28	.....	23.43	.....	22.98	.....	1,125	.....	856	.....	936	.....	10
	28.19	.....	20.41	.....	21.93	.....	1,046	.....	744	.....	905	.....	
Wheat													
1	10.56	.....	7.86	.....	5.95	.....	1,334	.....	926	.....	1,038	.....	1
2	19.78	9.32	21.90	13.73	17.41	11.21	2,205	967	2,420	1,489	2,701	1,684	2
3	16.33	5.97	16.90	8.42	13.31	6.87	1,720	579	1,644	709	2,158	1,163	3
4	10.26	.....	8.78	.....	6.68	.....	1,044	.....	940	.....	973	.....	4
5	13.28	3.13	14.26	5.28	12.23	5.74	1,475	430	1,498	550	1,973	982	5
6	15.77	5.72	18.46	9.28	17.48	11.18	1,743	698	2,014	1,057	2,670	1,663	6
7	9.95	.....	9.38	.....	6.11	.....	1,045	.....	965	.....	1,025	.....	7
8	20.69	10.87	25.26	16.47	20.88	14.80	2,510	1,463	2,724	1,810	3,208	2,239	8
9	19.01	9.33	22.45	14.25	19.12	13.10	2,159	1,110	2,181	1,323	2,846	1,933	9
10	9.55	.....	7.62	.....	6.00	.....	1,051	.....	805	.....	858	.....	10
	10.08	.....	8.41	.....	6.19	.....	1 119	.....	909	.....	973	.....	

THE 5-YEAR ROTATION

In this experiment corn, oats, wheat, clover and timothy are grown in succession on five tracts of land, A, B, C, D and E, containing 30 one-tenth acre plots each. Sections A and B of this test lie in Range VIII, south of the areas devoted to continuous cropping, while sections C, D and E occupy Range IX, near the east side of the farm.

The land was underdrained in 1893, and corn was grown that season on section C. The planting was delayed by the draining and the season proved unfavorable, so that the results of that season's work have not been included in the average. In 1894 wheat was harvested on section A, oats on section C and corn on section D. The clover and timothy followed the wheat on section A in 1895 and 1896, and the rotation has since been regularly followed.

Beginning with 1900, lime was applied to the west half of each plot in this rotation, fertilized and unfertilized alike, while the land was being prepared for corn, the lime being applied at the rate of one ton per acre of ground quicklime in 1900, 1901, 1902 and 1903, applied in the spring after plowing, and in the fall of 1903 for the crop of 1904. In 1905 the liming was changed to the east half, a ton of quicklime being used that spring, but in 1906 and 1907 ground limestone was used, at the rate of two tons per acre. No lime was applied in 1908. The table gives the average yield for the entire plot in each case, averaging the limed and unlimed halves.

In 1895 and 1896, and again in 1899, 1900 and 1901 the wheat in this test was injured by Hessian fly, the yield on the unfertilized land falling to a small fraction over one bushel per acre in 1896 and 1900.

Diagram II shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the five sections being arranged and treated exactly alike. Tables III and IV give the yields per acre for 1910 and for the average of the 17 years, and Table V shows the general results by periods.

DIAGRAM II: PLAN OF FERTILIZING IN 5-YEAR ROTATION

Plots one-tenth acre—Fertilizing materials in pounds per acre

Plot No.	On corn			On oats			On wheat			
	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	...	....	....	....	....	.. .	....	....	....	.. .
2	80	....	....	80	....	....	160	....	....	....
3	....	80	....	....	80	....	....	100	....	....
4	....	....	....	....	....	....	.. .	....	....	.. .
5	....	....	160	....	....	160	....	....	50	120
6	80	....	160	80	....	160	160	....	50	120
7	....	....	....	....	....	....	....	....	....	....
8	80	80	....	80	80	....	160	100	....	.. .
9	....	80	160	....	80	160	....	50	120	....
10	....	....	....	....	....	....	.. .	....	....	....
11	80	80	160	80	80	160	160	100	50	120
12	80	80	240	80	80	240	160	100	50	200
13	....	....	....	....	....	....	....	....	....	....
14	80	80	160	....	....	....	160	100	50	120
15	...	....	....	....	....	....	160	100	50	120
16	....	....	....	....	....	....	....	....	....	....
17	160	80	80	160	80	80	160	100	25	60
18	Barnyard manure, 8 tons on corn and wheat									
19	...	....	....	....	....	....	...	....	...	....
20	Barnyard manure, 4 tons on corn and wheat									
21	Same elements as 17, but nitrogen in oilmeal									
22	....	....	....	....	....	....	....	....	....	...
23	Same elements as 17, but nitrogen in dried blood									
24	Same elements as 17, but nitrogen in sulphate ammonia									
25	....	...	.. .	....	...	...	....	....	....	...
26	Same elements as 11, but phosphorus in bone meal									
27	Same elements as 11, but phosphorus in dissolved bone black*									
28	....	...	....	....	....	....	....	.. .	....	....
29	Same elements as 11, but phosphorus in basic slag									
30	Same elements as 17, but nitrogen in tankage									

*Previous to 1910. Since 1910 nitrogen in nitrate of lime and phosphorus in acid phosphate.

TABLE III: CROPS GROWN IN 5-YEAR ROTATION

Yield and increase per acre, 1910. Total fertilizing elements per acre for one rotation.

Plot No.	Fertilizing elements			Corn		Oats		Wheat		Hay		Plot No.
	Nitrogen Lbs.	Phosphorus Lbs.	Potassium Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Grain Bus.	Straw Lbs.	Clover Lbs.	Timothy Lbs.	
Yield per acre												
1	....	....	....	5.03	800	32.96	1,615	9.25	1,155	2,080	3,973	1
2	....	20	....	8.36	900	41.48	2,672	18.16	2,020	2,578	4,168	2
3	....	....	108	4.78	950	29.76	1,247	8.29	972	2,871	3,706	3
4	....	....	....	6.75	950	28.98	1,102	6.87	837	2,410	3,484	4
5	76	....	....	8.35	1,000	32.34	1,355	10.21	1,417	2,889	3,689	5
6	76	20	....	17.93	1,200	44 46	2,907	24.25	2,685	3,867	4,462	6
7	....	....	....	8.89	1,030	37.89	1,407	7 42	985	2,462	3,684	7
8	....	20	108	14.64	1,600	49.76	2,997	18.21	1,947	3,724	4,284	8
9	76	....	108	14 75	1,460	46 25	3,270	9.91	1,245	2,836	3,902	9
10	....	....	....	8.32	1,060	33.12	1,480	8.67	1,010	2,063	4,018	10
11	76	20	108	13.28	1,350	47.89	2,557	26.75	2,915	4,027	4,657	11
12	112	20	108	14.18	1,360	50.94	3,330	27.70	3,157	3,965	4,666	12
13	....	....	....	5.50	850	38.20	1,817	6.04	797	2,312	3,662	13
14	50	15	74	10.96	1,310	47.26	2,427	21.04	2,247	3,671	4,346	14
15	25	10	41	5.46	810	43.36	2,152	22.12	2,312	3,449	4,035	15
16	....	....	....	2.75	670	38.12	1,770	5.50	670	2,240	3,280	16
17	38	30	108	17.07	1,290	52.58	4,467	25.66	2,780	4,258	4,684	17
18	144	48	112	36.03	2,120	47.73	3,202	30.83	3,610	5,657	4,427	18
19	....	....	....	6.43	940	39.22	1,985	8.04	1,047	2,409	3,306	19
20	72	24	56	20.35	1,540	46.09	2,565	23 54	2,737	4,178	4,213	20
21	38	30	108	19.43	1,300	54 62	3,262	25.37	2,677	4,507	4,293	21
22	....	....	....	5.57	990	37.34	1,615	7.21	897	2,587	3,146	22
23	38	30	108	19.89	1,590	54.04	3,162	25.25	2,655	4,720	4,364	23
24	38	30	108	23 39	1,560	51.87	3,990	27.75	2,965	4,498	4,355	24
25	....	....	....	8.78	1,070	38.28	1,895	8.00	1,130	2,667	3,582	25
26	76	20	108	12.03	1,350	48.75	2,690	25.50	2,930	4,623	4,942	26
27	76	20	108	17.21	1,550	51 40	3,325	28 87	3,237	4,089	4,862	27
28	....	....	....	8 96	1,080	33.59	1,355	11.66	1,458	2,534	3,666	28
29	76	20	108	18.64	1,720	50.31	1,890	28.52	3,232	4,667	5,155	29
30	38	30	108	30.53	1,920	50.23	3,052	28.96	3,162	4,987	4,649	30
Average unfertilized yield				6.69	944	35.77	1,604	7.87	999	2,376	3,583	
Increase per acre												
2	....	20	....	2.76	50	9.85	1,228	9.70	971	388	358	2
3	....	....	108	—1.40	50	—.55	—26	.63	29	571	59	3
5	76	....	....	.89	23	.39	151	3.16	531	462	138	5
6	76	20	....	9.75	197	9.54	1,602	17.01	1,749	1,422	845	6
8	....	20	108	5.94	560	13.46	1,566	10.37	954	1,395	479	8
9	76	....	108	6.24	410	11.54	1,814	1.66	243	640	—25	9
11	76	20	108	5.90	360	13 08	962	18.96	1,976	1,881	738	11
12	112	20	108	7.74	440	14.43	1,625	20.78	2,289	1,736	875	12
14	50	15	74	6.38	520	9.09	626	15.18	1,492	1,383	811	14
15	25	10	41	1.79	80	5.21	366	16.44	1,600	1,185	628	15
17	38	30	108	13.09	530	14.09	2,625	19.31	1,984	1,962	1,395	17
18	144	48	112	31.83	1,260	8.88	1,289	23.64	2,689	3,304	1,130	18
20	72	24	56	14 21	583	7.50	703	15.78	1,740	1,710	960	20
21	38	30	108	13.57	327	16.65	1,524	17.88	1,730	1,979	1,094	21
23	38	30	108	13 25	573	15.39	1,454	17.78	1,680	2,106	1,073	23
24	38	30	108	15.68	517	13.90	2,188	20.01	1,913	1,858	918	24
26	76	20	108	3.19	277	12 03	975	16.28	1,691	2,000	1,332	26
27	76	20	108	8.31	473	16.25	1,790	18.43	1,888	1,511	1,224	27
29	76	20	108	9 68	640	16.72	535	16.86	1,774	2,133	1,489	29
30	38	30	108	21.57	840	16.64	1,697	17.30	1,704	2,453	983	30

TABLE IV: CROPS GROWN IN 5-YEAR ROTATION

Average annual yield and increase per acre for the 17 years, 1894-1910

Plot No.	Fertilizing Elements			Corn		Oats		Wheat		Hay		Plot No.
	Nitrogen Lbs.	Phosphorus Lbs.	Potassium Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Grain Bus.	Straw Lbs.	Clover Lbs.	Timothy Lbs.	
Yield per acre												
1	...	..	...	29.70	1,644	32.84	1,375	10.85	1,163	2,069	2,933	1
2	...	20	...	36.91	1,831	40.83	1,714	19.05	1,909	2,626	3,157	2
3	...	..	108	33.66	1,896	35.52	1,457	12.53	1,334	2,401	2,972	3
4	...	..	...	29.25	1,622	31.72	1,321	11.35	1,154	2,129	2,788	4
5	76	.	...	34.08	1,799	35 74	1,465	13.37	1,486	2,450	3,177	5
6	76	20	...	43.34	1,958	46.85	1,995	24.67	2,547	3,215	3,511	6
7	...	..	...	29.74	1,612	31.81	1,308	11.18	1,160	2,028	2,656	7
8	...	20	108	42.50	2,139	43.53	1,883	20 24	1,929	2,996	3,135	8
9	76	..	108	35.01	1,909	37.72	1,686	13 95	1,503	2,406	3,000	9
10	...	..	...	28.22	1,558	31.82	1,304	11.16	1,121	1,944	2,624	10
11	76	20	108	45.77	2,243	49.96	2,255	27 43	2,929	3,409	3,659	11
12	112	20	108	46.34	2,254	49.34	2,346	28.13	3,002	3,502	3,559	12
13	...	..	...	28.41	1,590	31.94	1,361	11.14	1,146	2,001	2,635	13
14	50	15	74	42 82	2,147	39.78	1,732	25.55	2,695	3,049	3,291	14
15	25	10	41	33.30	1 811	33.21	1,386	24.42	2,536	2,638	2,990	15
16	.	..	...	26.48	1,592	30.22	1,255	9 96	986	1,804	2,506	16
17	38	30	108	42.50	2,229	48.44	2,341	22.96	2,347	3,172	3,292	17
18	144	48	112	47 21	2,423	42.61	2,022	21.92	2,399	3,944	4,043	18
19	...		...	30.31	1,703	31.41	1,341	10.87	1,122	1,945	2,626	19
20	72	24	56	42.64	2,163	37.98	1,693	18.22	1,958	3,019	3,501	20
21	38	30	108	45.17	2,228	47.62	2,202	24.06	2,517	2,984	3,139	21
22	...	..	...	27.21	1,642	30.70	1 279	10.44	1,045	1,716	2,366	22
23	38	30	108	44.97	2,226	47.84	2,149	22.94	2,312	2,916	3,118	23
24	38	30	108	45.24	2,244	49 15	2,376	23.64	2,398	3,066	3,049	24
25	...	..	...	30.04	1,723	32.00	1,389	11.40	1,199	1,989	2,680	25
26	76	20	108	44.08	2,283	47.33	2,094	24.16	2,499	3,559	3,730	26
27	76	20	108	46.04	2,292	49.59	2,296	26.89	2,771	3,153	3,550	27
28	...	..	...	31.58	1,784	33.47	1,389	11.28	1,101	2,049	2,906	28
29	76	20	108	46.33	2,378	47.89	2,099	25.26	2,653	3,327	3,894	29
30	38	30	108	46.24	2,229	44.94	1,995	22.89	2,259	3,363	3,808	30
Average unfertilized yield				29.09	1,646	31.78	1,334	10.98	1,122	1,967	2,494	
Increase per acre												
2	...	20	...	7.36	195	8.40	357	8.03	749	536	272	2
3	...	..	108	4.25	268	3.45	118	1.35	178	291	135	3
5	76	.	...	4 67	180	3.99	148	2 07	331	355	433	5
6	76	20	...	13.76	342	15.07	683	13.42	1,389	1,153	811	6
8	...	20	108	13.27	545	11.72	576	9.07	782	996	489	8
9	76	..	108	6 28	333	5.90	380	2.78	369	434	366	9
11	76	20	108	17.49	674	18.10	932	16.29	1,800	1,446	1,031	11
12	112	20	108	17.99	675	17.43	1,004	16.98	1,864	1,520	927	12
14	50	15	74	15.07	556	8.41	406	14.81	1,602	1,114	699	14
15	25	10	41	7.43	255	3 46	170	14 07	1,497	796	442	15
17	38	30	108	17 91	600	17.82	1,057	12.70	1,316	1,321	746	17
18	144	48	112	21.65	756	11 01	702	11.35	1,323	2,046	1,457	18
20	72	24	56	13.36	480	6.80	373	7.49	861	1,150	961	20
21	38	30	108	16.93	565	16.61	880	13.48	1,446	1,192	686	21
23	38	30	108	16.81	557	16.71	833	12.18	1,215	1,108	647	23
24	38	30	108	16.14	548	17.58	1,024	12.56	1,250	1,168	473	24
26	76	20	108	13.52	540	14.84	705	12 80	1,333	1,550	974	26
27	76	20	108	14 97	527	16 61	907	15.58	1,638	1,125	719	27
29	76	20	108	14.75	594	14.42	709	13.98	1,552	1,278	988	29
30	38	30	108	14.66	444	11.47	605	11.61	1,158	1,314	902	30

TABLE V: TOTAL FERTILIZING MATERIALS AND THEIR COST, AND TOTAL AND NET VALUE OF INCRREASE PRODUCED FOR 5-YEAR PERIODS AND FOR 17 YEARS, ALL CALCULATED FOR ONE ROTATION OF 5 YEARS

Plot No.	Fertilizing materials in pounds per acre for each rotation	Cost of fertilizers for each rotation	Average value of total increase per acre for each rotation				Net gain or loss (—) from fertilizers for each rotation				Plot No.
			First 5-years	Second 5-years	Third 5-years	17-year average Total	First 5-years	Second 5-years	Third 5-years	17-year average Net	
2	Acid phosphate, 320	$ 2 60	$ 8.50	$17.37	$24.32	$16.52	$ 5.90	$14 77	$21.72	$13.92	2
3	Muriate potash, 260	6.50	5.19	4.67	9.17	6 22	—1.31	—1.83	2 67	—0 28	3
5	Nitrate soda, 440; dried blood, 50	14.40	4.70	10.40	9 03	8 62	—9.70	—4 00	—5 37	—5.78	5
6	Acid phosphate, 320; nitrate soda, 440; dried blood, 50	17 00	19 09	35.27	39.75	31.21	2 09	18.27	22 75	14.21	6
8	Acid phosphate, 320; muriate potash, 260	9.10	14.40	24.37	33 51	24.19	5.30	15 27	24.41	15.09	8
9	Muriate potash, 260; nitrate soda, 440; dried blood, 50	20.90	5.85	11.35	13.23	10.95	—15 05	—9.55	—6 67	—9.95	9
11	Acid phos., 320; mur. potash, 260; nit. soda, 440; dried blood, 50	23.50	23.39	42.43	49.96	39.13	2.80	18.93	26.46	15 63	11
12	" " 320; " " 260; " " 680; " " 50	30.70	26.16	45.53	48 24	39.68	—4.54	14.83	17 54	8.98	12
14	" " 240; " " 180; " " 280; " " 50	16.05	21.37	32.91	37.33	30.49	5.32	15.86	21 28	14 44	14
15	" " 160; " " 100; " " 120; " " 50	8.60	13.89	22.86	27.13	22.26	5 29	14.26	18.53	13.66	15
17	" " 480; " " 260; " " 220; " " 25	17.60	15.74	36.61	46.28	34 21	—1.86	19.01	28.68	16.61	17
18	Yard manure, 16 tons	?	19 82	34.24	55.94	38.21	?	?	?	?	18
20	Yard manure, 8 tons	?	13.02	21.28	35.36	23 77	?	?	?	?	20
21	Same elements as 17, but nitrogen in oilmeal	17 60	20.43	36.25	42.24	33 22	2.83	18.65	24.64	15.62	21
23	" " " 17, " " " " dried blood	17.60	19.09	34.37	39.28	31.38	1.49	16.77	21.68	13.78	23
24	" " " 17, " " " " sulphate ammonia	17.60	20 70	32.77	38.71	31.44	3.10	14.77	21.11	13 84	24
26	" " " 11, " phosphorus in bonemeal	23.50	20.89	36.17	42 55	33.44	—2.61	12.67	19.05	9 94	26
27	" " " 11, " " " dissolved boneblack*	23.50	19 86	39.88	42.08	34.14	—3 64	16.38	18.58	10.64	27
29	" " " 11, " " " basic slag	23.50	21.91	39 32	39.04	33.62	—1.59	15 82	15.54	10 12	29
30	" " " 17, " nitrogen in tankage	**17.60	13.74	30.51	41.62	29.88	....	12.90	24.02	12.28	30

The nearest practicable approach to a common denominator for the various kinds of produce grown in this rotation is their market value, and in Table V the results of the test are arranged on this basis for three 5-year periods and for the entire 17 years, corn being rated at 40 cents per bushel, oats at 30 cents, wheat at 80 cents, hay at $8.00 per ton, stover at $3.00 and straw at $2.00; valuations much below present prices for the grains, but not far from the average values during the period of the test.

The fertilizing materials are valued at a fraction over $16.00 per ton for acid phosphate, 2½ cents per pound for muriate of potash and 3 cents per pound for nitrate of soda; and it is assumed that the cost per pound of the fertilizing elements will be practically the same in the other carriers used on Plots 21 to 30 inclusive.

The table shows that the effectiveness of the fertilizers and manure has increased with each successive period, the greatest relative increase being shown by the manure. Taking the second part of the table, giving the net gain after deducting the cost of the fertilizers, it will be seen that eight of the fertilizer applications failed to produce sufficient increase to cover their cost; during the second period three, and during the third period two. Every complete fertilizer has been used with a profit since the first period, but when either nitrate of soda or muriate of potash has been used unaccompanied by some carrier of phosphorus there has been a loss in each period and in the average of the 16 years.

Nevertheless, both nitrogen and potassium are essential to the highest net profit, as shown by comparing Plot 2, receiving phosphorus only, with Plot 8, receiving potassium in addition, and Plot 11, receiving these with nitrogen.

The results of the comparison of different carriers of nitrogen and phosphorus have been discussed in Circular No. 93.

*Previous to 1910. Since 1910 nitrogen in nitrate of lime and phosphorus in acid phosphate.

**Since first period. Smaller application during first period.

THE POTATOES-WHEAT-CLOVER ROTATION

This experiment is located on the South Farm, southeast of the orchards, and contains three sections of 34 plots each. The south section (A) and about half of the middle section (B) had been in cultivation for an unknown period before the test began. The north part of section B and all of the north section (C) were cleared from the forest for the purposes of this test. The old land was tile drained in 1893 and the work was begun by planting Section A to potatoes in 1894. Wheat and clover followed in 1895 and 1896 and the rotation has been maintained regularly since.

The potato crops in this test have in some seasons been somewhat injured by blight, and in 1904 a dashing rain, coming just after the potatoes had been planted, washed much of the seed out of the ground. These difficulties have caused an irregular stand, and for this reason the attempt has been made to correct the yields on the basis of the average stand obtained on the unfertilized plots, but this method has not proved satisfactory and hence the actual yields are given in the table. In 1909 the potatoes were reduced to about one-third the average crop by a combined attack of white grub and Fusarium wilt, the latter causing the larger part of the injury. The crop was severely injured by wilt again in 1910.

In 1895 and 1896 the wheat in this test was severely injured by Hessian fly, but it escaped the attack of 1899 to 1901.

In 1900 the clover failed; attempts were made to grow crimson clover and soybeans in its stead, but there was failure in securing a stand of these crops also, so that it has been necessary to omit that season from the calculations. In 1905 continuous rains prevented harvesting the clover until very late, and caused the fertilized plots to lodge, so that these plots weighed less than those not fertilized, though earlier in the season they had shown a distinctly stronger growth. As there was no way by which the yields could be corrected and as it seemed desirable to include the crop in the general average because of its effect on the average unfertilized yield it has been so included, although the doing so slightly reduces the apparent average effect from the fertilizers.

Diagram III shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the three sections being arranged and treated alike. Tables VI and VII give the yield per acre for 1910 and for the 17 years, 1894-1910.

DIAGRAM III: PLAN OF FERTILIZING IN POTATOES-WHEAT-CLOVER ROTATION

PLOTS ONE-TENTH ACRE — Fertilizing materials in pounds per acre

Plot No.	On Potatoes			On Wheat			
	Acid Phosphate	Muriate of potash	Nitrate of soda	Acid Phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	....	....	....	....	....	....	....
2	160	....	....	160	....	....	....
3	....	100	....	....	100	....	....
4	....	....	....	....	....	....	....
5	....	....	80	....	....	50	120
6	160	....	80	160	....	50	120
6	....	....	....	....	....	....	....
8	160	100	....	160	100	....	....
9	....	100	80	....	100	50	120
10	....	....	....	....	....	....	....
11	160	100	80	160	100	50	120
12	160	100	160	160	100	50	200
13	....	....	....	....	....	....	....
14	320	200	160	160	100	50	120
15	480	300	320	....	....	....	....
16	....	....	....	....	....	....	....
17	....	....	....	Manure, 4 tons on wheat			
18	....	....	....	Manure, 8 tons on wheat			
19	....	....	....	....	....	....	....
20	160	100	80	160	100	25	60
21	Same elements as 20, but nitrogen in oilmeal						
22	....	....	....	....	....	....	....
23	Same elements as 20, but nitrogen in dried blood						
24	Same elements as 20, but nitrogen in sulphate ammonia						
25	....	....	....	....	....	....	....
26	Same elements as 11, but phosphorus in bone meal						
27	Same elements as 11, but phosphorus in dissolved bone black						
28	....	....	....	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag						
30	Manure, 8 tons on potatoes			....	....	....	....
31	....	....	....	....	....	....	....
32	....	....	....	Manure, 16 tons on wheat			
33	Same elements as 20, but nitrogen in tankage						
34	....	....	....	....	....	....	....

CROPS IN 3-YEAR ROTATION OF POTATOES, WHEAT AND CLOVER

TABLE VI: Yield per acre, 1910, and average for 17 years, 1894-1910

Fertilizing elements for each rotation

Plot No.	Fertilizing elements: Nitrogen Lbs.	Phosphorus Lbs.	Potassium Lbs.	Potatoes: 1910 Bus. (actual)	Potatoes: 17-yr. av. Bus.	Wheat: 1910 Grain Bus.	Wheat: 1910 Straw Lbs.	Wheat: 16-year av. Grain Bus.	Wheat: 16-year av. Straw Lbs.	Clover: 1910 Lbs.	Clover: 15-yr. av. Lbs.	Plot No.
1	...	..	...	70.25	154 43	26.33	3,473	30.84	3,225	5,298	4,334	1
2	. .	20	...	69.08	167 97	35.44	4,141	36.54	3,856	5,742	4,574	2
3	...	..	83	96.67	167.60	21.67	2,478	32.41	3,061	5,351	4,215	3
4	...	..	...	75 42	158.47	20.99	2,519	30.51	3,026	5,031	3,929	4
5	38	..	...	80.50	163 16	21.01	2,996	30.77	3,261	5,191	4,207	5
6	38	20	...	87.92	170.01	30.97	3,969	36.51	3,925	5,209	4,352	6
7	...	..	...	77 00	145.44	22.09	2,975	28.64	2,845	4,231	3,813	7
8	...	20	83	102 05	178.42	38.62	4,282	36.48	3,445	5,280	4,151	8
9	38	..	83	99 92	162.71	25.00	3,040	34.56	3,304	5,158	4,338	9
10	...	..	...	66 33	147.72	23.54	2,887	29.89	2,834	4,942	3,740	10
11	38	20	83	103.25	173 57	34.12	4,452	38.64	3,877	5,778	4,275	11
12	50	20	83	107.42	180.53	33.17	4,370	38.38	4,008	5,849	4,482	12
13	...	..	...	67.83	146.24	20.96	2,782	29.15	2,777	5,084	3,879	13
14	50	30	124	108 75	181.88	33.33	4,220	38.31	3,977	5,831	4,430	14
15	50	30	124	100.75	177.54	33.54	3,947	37.09	3,658	5,671	4,400	15
16	...	..	...	67.58	137.06	22.25	3,025	27.79	2,581	4 356	3,589	16
17	36	12	28	89 75	150.89	29.21	3,387	32.02	3,180	5,013	4,208	17
18	72	24	56	100 50	157.14	32.71	4,157	33.29	3,301	5,511	4,614	18
19	...	..	...	68 50	135.28	19.62	2,282	25.01	2,453	4,302	3,332	19
20	25	20	83	102 58	177.75	35.33	4,120	34.69	3,465	5,404	4,191	20
21	25	20	83	94 33	169.13	35 58	4,125	34.83	3,367	5,120	3,792	21
22	..	..	...	62.50	137.30	17.58	2,385	24.60	2,285	3,822	3,359	22
23	25	20	83	103.25	166.02	35.37	4,157	35.45	3,418	4,604	3,819	23
24	25	20	83	104.25	172.82	36.75	4,095	35.52	3,346	4,729	3,817	24
25	...	..	...	72.17	137.12	21.83	2,710	25.28	2,401	4,089	3,413	25
26	38	20	83	107 50	167.37	31.16	3,590	35.81	3,461	5,049	4,188	26
27	38	20	83	112.83	173.32	35.50	4,370	37.24	3,786	5,156	4,008	27
28	...	..	...	74.42	139.51	26.37	3,237	25.62	2,526	3,964	3,532	28
29	38	20	83	108.83	171.85	35.50	4,490	37.66	3,817	4,747	4,429	29
30	72	24	56	107.75	182.96	34.00	4,300	32.63	3,229	5,084	4,361	30
31	...	..	...	71.83	144.33	25.37	3,337	25.42	2,522	4,053	3,444	31
32	144	48	112	110.58	188.61	34.12	4,632	38.74	4,036	5,973	5,043	32
33	25	20	83	99.17	173.39	36.29	3,612	38.83	3,619	5,298	4,077	33
34	...	..	...	87.17	138.19	24.33	3,460	27.27	2,629	4,658	3,505	34
Average unfertilized yield				71 75	143.22	22.27	2,919	27.29	2,660	4,486	3,664	

TABLE VII: Increase per acre, 1910, and annual average for 17 years, 1894-1910

Cost of fertilizer for 1 rotation and 17-year average value of increase for each rotation

Plot No.	Potatoes: 1910 Bus. (actual)	Potatoes: 17-yr. av. Bus.	Wheat: 1910 Grain Bus.	Wheat: 1910 Straw Lbs.	Wheat: 16-year av. Grain Bus.	Wheat: 16-year av. Straw Lbs.	Clover: 1910 Lbs.	Clover: 15-yr. av. Lbs.	Cost of fertilizer	Value of increase for one rotation: Total	Value of increase for one rotation: Net	Plot No.
2	—2.89	12.20	10.89	986	5.83	696	533	376	$2.60	$11 74	9.14	2
3	22.97	10.48	—1.10	—359	1.79	—31	231	151	5.00	6.20	1.20	3
5	4.55	9.03	—0.35	342	.88	295	427	316	7.20	5.87	—1.33	5
6	11.45	20.23	9.25	1,179	7.24	1,020	711	500	9.80	16.90	7.10	6
8	29.06	32.22	16.05	1,370	7.42	603	812	362	7.60	20.90	13.30	8
9	30.03	15.74	1.94	140	5.08	466	433	575	12.20	13.12	.92	9
11	36.42	26.35	11.44	1,600	8 99	1,062	789	488	14 80	20.74	5.94	11
12	40.09	33.78	11.35	1,553	8.98	1,212	812	649	19.60	24.50	4.90	12
14	41.00	38 70	11.94	1,357	9.61	1,266	990	647	21.00	27.02	6.02	14
15	33.09	37.42	11.72	1,003	8.86	1,012	1,072	714	21.00	25 92	4.92	15
17	21.86	16.05	7.84	610	5.15	643	675	705	?	14.00	?	17
18	32.31	22.64	12.21	1,627	7.29	806	1,191	1,195	?	20.47	?	18
20	36.08	41.81	16.39	1,804	9.82	1,068	1,262	849	12.40	29.04	16.64	20
21	29.83	32.51	17.32	1,774	10.09	1,026	1,138	442	12.40	23.87	11.47	21
23	37.53	28.75	16.37	1,664	10.62	1,095	693	442	12.40	22.86	10.46	23
24	35.31	35.64	16.34	1,493	10.46	984	729	422	12.40	25.29	12.89	24
26	34.58	29.45	7.82	704	10.42	1,018	1,002	735	14.80	24.08	9.28	26
27	39.16	34.61	10.64	1,309	11.73	1,302	1,150	516	14.80	26.59	11.79	27
29	35.27	30.74	9.46	1,220	12.10	1,292	753	922	14.80	26.95	12.15	29
30	35.06	40.24	8.30	996	7.15	706	1,061	879	?	26.04	?	30
32	33.64	44.93	9.10	1,254	10.86	1,292	1,718	1,579	?	34.27	?	32
33	17.11	32.48	11.61	193	11.25	933	842	593	12.40	25.29	12.89	33

BARNYARD MANURE TEST

COMPARISON OF YARD WITH FRESH MANURE

THE REINFORCEMENT OF MANURE

This experiment was begun in 1897 for the purpose of comparing manure which has lain for some months in an open barnyard with that taken directly from the stable to the field, and of studying the effect of treating the manure with several absorbent or reinforcing materials.

In this investigation a lot of manure has been taken from the open barnyard, where it has been accumulating during the winter, and divided into four parcels. With one parcel is mixed the finely ground, phosphatic rock, known as floats, from which acid phosphate is made by mixing it with sulphuric acid; with another parcel acid phosphate is mixed; with a third, the crude potash salt, known as kainit, and with a fourth, land plaster or gypsum; the reinforcing materials being used at the uniform rate of 40 pounds per ton of manure. At the same time manure taken from box stalls, where it has accumulated under the feet of animals kept continuously in their stalls, is divided into similar parcels and treated with like quantities of the same materials.

After a few weeks the manure thus treated, together with two lots of untreated manure, one taken from the yard and one from the stable, is spread upon clover sod at the rate of eight tons per acre and plowed under for corn, the corn being followed by wheat and clover in a 3-year rotation. During the first three seasons soybeans were grown, because of clover failure, and were plowed under.

Three tracts of land, A, B and C, are included in the test, each crop being grown every season. The arrangement of these tracts and the plan of fertilizing are shown in Diagram IV, and the results are given in Tables VIII and IX.

DIAGRAM IV: ARRANGEMENT OF PLOTS AND PLAN OF FERTILIZING IN EXPERIMENTS WITH MANURE

PLOTS ONE-SIXTEENTH ACRE

11	Nothing			Nothing	1
12	Yard manure and gypsum			Yard manure and floats	2
13	Stall manure and gypsum			Stall manure and floats	3
14	Nothing			Nothing	4
15	Yard manure, untreated			Yard manure and acid phos.	5
16	Stall manure, untreated			Stall manure ahd acid phos.	6
17	Nothing			Nothing	7
18	Chemical fertilizer			Yard manure and kainit	8
19	Chemical fertilizer			Stall manure and kainit	9
20	Nothing			Nothing	10
		SECTION A			
11	Nothing			Nothing	1
12	Yard manure and gypsum			Yard manure and floats	2
13	Stall manure and gypsum			Stall manure and floats	3
14	Nothing			Nothing	4
15	Yard manure, untreated			Yard manure and acid phos.	5
16	Stall manure, untreated			Stall manure and acid phos.	6
17	Nothing			Nothing	7
18	Chemical fertilizer			Yard manure and kainit	8
19	Chemical fertilizer			Stall manure and kainit	9
20	Nothing			Nothing	10
		SECTION B			
11	Nothing			Nothing	1
12	Yard manure and gypsum			Yard manure and floats	2
13	Stall manure and gypsum			Stall manure and floats	3
14	Nothing			Nothing	4
15	Yard manure, untreated			Yard manure and acid phos.	5
16	Stall manure, untreated			Stall manure and acid phos.	6
17	Nothing			Nothing	7
18	Chemical fertilizer			Yard manure and kainit	8
19	Chemical fertilizer			Stall manure and kainit	9
20	Nothing			Nothing	10
		SECTION C			

NORTH

TABLE VIII: BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION

Average yield per acre 1910 and 14 years 1897-1910

Plot No.	Manure and treatment	1910					14 years, 1897-1910					Plot No.
		Corn, Sec. C		Wheat, Sec A		Clover Sec. B Lbs.	Corn 13* crops		Wheat 13 crops		Hay 10 yrs. Lbs.	
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.		
		Yield per acre										
1	None	29.96	2,336	14.27	2,248	3,248	36 60	2,231	12.93	1,573	2,828	1
2	Yard manure and floats	48.34	3,008	22.80	3,160	4,523	58.56	3,290	25.40	2,765	4,202	2
3	Stall manure and floats	48.34	3,456	25.20	3,448	4,935	62.16	3,557	26.86	2,967	4,784	3
4	None	21.26	1,872	12.87	1,996	2,901	30 28	1,998	11 45	1,352	2,134	4
5	Yard manure and acid phosphate	52 46	2,944	24.20	3,188	4,864	59.67	3,250	26.07	2,819	4,052	5
6	Stall manure and acid phosphate	55.77	3,520	26.73	3,788	5,461	63.71	3,474	26.76	2,981	4,764	6
7	None	20.97	1,952	9.67	1,676	2,816	30.07	1,969	10.06	1,255	2,113	7
8	Yard manure and kainit	44.46	3,361	25.40	3,484	3,797	53 84	3,169	21.84	2,482	3,405	8
9	Stall manure and kainit	45.89	3,440	26.13	3,536	4,295	58 97	3,491	23 54	2,783	4,215	9
10	None	16.23	1,648	12.60	2,012	3,527	31.61	1,976	10.85	1,318	2,378	10
11	None	34.06	2,560	14.53	2,216	3,484	36.62	2,350	13.91	1,719	3,063	11
12	Yard manure and gypsum	55.43	3,424	24.40	3,464	4,110	57.78	3,368	25 19	2,759	3,691	12
13	Stall manure and gypsum	47.60	3,296	24.40	3,400	4,352	59.65	3,530	24.09	2,714	3,737	13
14	None	18.34	1,952	10.13	1,696	3,541	30 55	2,002	10 72	1,253	2,165	14
15	Yard manure, untreated	44.11	2,720	23.20	3,136	4,252	50.63	2,873	20.09	2,260	3,060	15
16	Stall manure, untreated	52.06	3,520	25.07	3,600	5,404	57.69	3,321	21.63	2,445	3,769	16
17	None	27.80	2,626	9.13	1,676	3,840	35.88	2,328	11.17	1,379	2,437	17
18	Chemical fertilizer†	43.94	2,912	20.40	2,728	3,684	43 18	2,612	14.70	1,718	3,004	18
19	Chemical fertilizer‡	28 23	2,496	17.13	2,460	4,366	43.13	2,459	15 60	1,883	3,178	19
20	None	16.40	1,824	12.60	1,932	3,812	32.73	2,009	11.50	1,347	2,608	20
	Average unfertilized yield	23.13	2 096	11.97	1,956	3,396	33.04	2,107	11 53	1,373	2,435	

*Excluding crop of 1909, which was so injured by grub worms that no comparison is possible.

†Acid phosphate, 80 lbs.; muriate of potash, 80 lbs.; nitrate of soda, 160 lbs.

‡Acid phosphate, 80 lbs.; muriate of potash, 10 lbs.; tankage (7-30), 100 lbs.

TABLE IX: BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION

Average annual increase and its value (excluding corn crop of 1909)

Plot No.	Manure and treatment	Average annual increase per acre					Cost of treatment per acre	Value of increase*	
		Corn 13 crops		Wheat 13 crops		Hay 10 crops Lbs.		Total per acre	Net per ton of manure
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.				
2	Yard manure and floats	24.08	1,136	12.98	1,266	1,605	$1.40	$29.40	$3.50
3	Stall manure and floats	29.78	1,481	14.97	1,541	2,418	1.40	37.32	4.49
5	Yard manure and acid phos.	29.46	1,262	15.08	1,499	1,925	2.40	34.94	4.07
6	Stall manure and acid phos.	33.57	1,495	16.17	1,694	2,644	2.40	40.87	4.81
8	Yard manure and kainit	23.26	1,198	11.42	1,206	1,203	2.70	26.25	2.94
9	Stall manure and kainit	27.88	1,517	12.91	1,486	1,924	2.70	32.94	3.78
12	Yard manure and gypsum	23.18	1,134	11.55	1,195	928	1.00	25.12	3.02
13	Stall manure and gypsum	27.08	1,412	12.31	1,306	1,273	1.00	29.19	3.52
15	Yard manure untreated	18.30	762	9.99	965	804	....	20.63	2.58
16	Stall manure untreated	23 59	1,102	10.62	1,107	1,427	....	26.54	3.32
18	Chemical fertilizer[1]	8.35	390	3.71	350	509	7 45	9.28	....
19	Chemical fertilizer[2]	9 35	343	4.78	525	626	2.30	11.09	....

[1]Acid phosphate, 80 lbs; muriate of potash, 80 lbs; nitrate of soda, 160 lbs.
[2]Acid phosphate, 80 lbs; muriate of potash, 10 lbs; tankage, (7-30) 100 lbs.
* See page 11 for valuations.

In all these experiments the increase has been computed on the assumption that changes in the natural fertility of the soil are likely to be progressive; that is, that if the yields of Plots 1 and 4, unfertilized, were 30 and 33 bushels, respectively, those of Plots 2 and 3 would probably have been 31 and 32 bushels, had no fertilizers been applied. As a rule the outcome of the work has justified this assumption, but in the manure test the yields of Plots 1 and 11, Section C, have been so much larger than those of the other unfertilized plots of the series that the question has been raised whether these plots (which are continuous) may not have been located on a strip of land—such as an old fence row—which has not been so depleted of its fertility under previous management as that covered by the adjoining plots.

In Table X the average total yields obtained on the plots treated with floats and acid phosphate are arranged by sections:

TABLE X: Average total yields in plots treated with floats and acid phosphate, arranged by sections

Crop and Section*		Yard manure		Stall manure	
		With floats	With acid phosphate	With floats	With acid phosphate
Corn, bus:	A	54.85	50.99	57.86	58.21
	B	67.50	70.04	71.64	70.71
	C	54.39	58.31	58.04	62.52
Wheat, bus:	A	22.05	23.22	29.89	24.95
	B	30.47	31.80	31.53	29.67
	C	24.50	23.88	24.65	26.15
Hay, lbs:	A	4,610	4,072	5,262	4,835
	B	3,720	3,836	4,030	4,007
	C	4,437	4,321	5,312	5,703

*The differences in yield of the different sections are chiefly due to seasonal differences, not to variation of soil.

In 10 of the 18 comparisons given in Table X the total yields on the plots treated with acid phosphate have exceeded those on the plots treated with floats. The general average of all the sections is shown below:

AVERAGE TOTAL YIELD PER ACRE

	Corn Bus.	Wheat Bus.	Hay Lbs.
Yard manure and floats	58.56	25.40	4,202
Yard manure and acid phosphate	59.67	26.07	4,052
Stall manure and floats	62.16	26.86	4,784
Stall manure and acid phosphate	63.71	26.76	4,764

LIME AND FLOATS TEST

This experiment was begun in 1905 in a 3-year rotation of corn, oats and clover, for the purpose of comparing the effect of different forms of lime and of obtaining further experience in the use of floats.

The land had been under the regular rotative cropping of the farm since its occupation by the Station, and for a considerable period before, and was in good condition. Twelve tons of manure per acre had been plowed under for corn 1904. Three sections of 26 plots each are included in the test, the plots containing one-twentieth acre each.

For the crops of 1905 Section A (north end) was manured at the rate of 6 tons per acre only, because of the recent application above mentioned, limed and fertilized and planted in corn. Section B was sown to soybeans instead of clover, the beans to be followed by rye in the fall and corn in 1906. Section C (south end) was limed and fertilized without manure and sown to oats and clover. Thenceforth the manure, lime and fertilizers have all been applied to the corn crops, the manure being plowed under and the lime and fertilizers applied on the surface. The oats and clover receive no treatment.

The clover seeding failed in 1906, 1908 and 1909, and soybeans were sown instead and harvested as hay. As the soybean suffers less from lack of lime than clover the result has been a smaller apparent effect from the lime than might otherwise have been found.

The plan of treatment and average results of the work for the first six years are given in Table XI.

It is too early to attempt to draw conclusions from this experiment. For a soil which is capable of producing a 6-year average of 57 bushels of corn, followed by 52 bushels of oats and 2 1-2 tons of clover hay without any treatment the chief problem is that of maintaining this rate of yield.

So far as present results may be accepted as a guide they support other experiments of the Station in indicating that ground limestone and floats should be used only as reenforcements of manure or fertilizer and never as substitutes.

TABLE XI: CROPS GROWN IN 3-YEAR ROTATION UNDER TREATMENT WITH MANURE, LIME AND FLOATS

AVERAGE YIELD AND INCREASE FOR 6 YEARS, 1905-1910 INCLUSIVE

Plot No.	Treatment (Lime, manure etc., per acre applied to corn only)	Yield per acre					Increase per acre					Total value of increase	Cost of lime and fertilizer	Net gain or loss (—) per acre	Gain per ton of manure	Plot No.
		Corn, 6 years		Oats, 6 years		Hay 5 yrs. Lbs.	Corn 6, years		Oats, 6 years		Hay 5 yrs. Lbs.					
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.						
1	None	58.42	3,233	49 30	2,846	5,120	.....	....	....	....	....	.....	....	$....	....	1
2	Caustic lime, 500 lbs.; manure, 8 tons	70.52	3,813	55 38	2,984	5,622	12.21	551	4.75	214	449	$9.14	$1.50	7.64	0.95	2
3	Caustic lime, 1,000 lbs.; manure, 8 tons	72.27	3,903	55.68	2,978	5,829	14.08	612	3.71	285	620	10.42	3.00	7.42	0.93	3
4	None	58.07	3,320	53.30	2,617	5,281	.....	....	....	....	....	.....	..	....	....	4
5	Caustic lime, 2,000 lbs.; manure; 8 tons	74.34	4,060	56.57	3,042	6,481	15 58	734	3.17	435	1,137	13 26	6 00	7.26	0.91	5
6	Ground limestone, 1780 lbs.; manure, 8 tons	74.44	3,937	57.56	2,958	6,162	14.99	606	4.05	361	757	11.51	2.70	8.81	1.10	6
7	None	60.14	3,337	53 60	2,587	5,467	.....	....	....	....	....	.....	....	....	....	7
8	Air slaked lime, 1,780 lbs.; manure, 8 tons	73.25	4,053	57.03	3,078	6,158	13.07	731	4.29	542	803	11.36	5.30	6.06	0 76	8
9	Hydrated lime, 1,320 lbs.; manure, 8 tons.	73.09	4,017	56.89	3,049	5,991	12.88	709	5.02	564	748	11.27	4.00	7.27	0.91	9
10	None	60.25	3,293	51 01	2,434	5,131	.....	....	....	....	....	.....	....	....	....	10
11	Gypsum, 1,000 lbs.; manure, 8 tons	68 56	3,730	56.64	2,657	5,108	9.54	488	5.28	270	89	6.75	3 00	3.75	0 47	11
12	Floats, 1,000 lbs.; manure, 8 tons	69.57	3,730	57.97	2,765	5,293	11.78	539	6.25	425	385	9.36	4.50	4.86	0.61	12
13	None	56.56	3,140	52.08	2,293	4,797	.....	....	....	....	....	....	....	....	....	13
14	Caustic lime, 1,000 lbs.	61.33	3,557	53.84	2,497	5,088	5.09	417	1.42	211	367	4.66	3.00	1.66	....	14
15	Ground limestone, 1,780 lbs.	58.29	3,157	51.87	2,307	4,865	2.36	17	—.88	28	219	1.60	2.70	—1.10	....	15
16	None	55.61	3,140	53.09	2,271	4,571	.....	....	....	....	....	.....	....	....	....	16
17	Caustic lime, 1,000 lbs.; acid phos., 320 lbs.; muriate potash, 40 lbs.	70.64	3,770	56.01	2,457	5,594	14.05	603	3.05	169	935	11.34	6.60	4.70	....	17
18	Caustic lime, 1,000 lbs.; floats, 320 lbs.; muriate potash, 40 lbs.	68.60	3,737	53.99	2,339	5,575	11.02	543	1.16	33	829	8.92	5.45	3.47	....	18
19	None	58.56	3,220	52.69	2,324	4,834	.....	....	....	....	....	.....	....	....	....	19
20	Acid phosphate, 320 lbs.	65 22	3,477	52.16	2,301	5,154	6.84	287	—.20	16	271	4.32	2.60	1.70	....	20
21	Acid phos., 320 lbs.; mur. of potash 40 lbs.	69 20	3,750	54 04	2,441	5,396	10.99	590	2.00	196	463	7.92	3.60	4.32	....	21
22	None	58.03	3,130	51.72	2,205	4,982	.....	....	....	....	....	....	....	....	....	22
23	Floats, 320 lbs.	59.67	3,127	52.00	2,252	4,941	3.09	51	.74	55	81	1.91	1.45	0.46	....	23
24	Floats, 320 lbs.; muriate of potash, 40 lbs.	61.48	3,407	50.79	2,164	4,741	6.35	386	...	—26	3	3.10	2.45	0.65	....	24
25	None	53.67	2,967	50.33	2,182	4,616	.....	....	....	....	....	.....	....	....	....	25
26	Floats, 320 lbs.; mur. of potash, 40 lbs.; dried blood, 100 lbs.*	58.87	3,347	52.58	2,595	4,702	5.20	380	.57	—8	86	3.15	3.85	—0.70	....	26
	Average unfertilized yield	57.70	3 198	51.90	2 418	4 977	*Beginning with 1909 Plot 26 recieves manure only									

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